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Phytopathological Classics

NUMBER I

ATTEMPT AT A DISSERTATION ON THE DISEASES OF PLANTS

By JOHANN CHRISTIAN FABRICIUS

1774

A Translation

By MRS. MARGARET KØLPIN RAVN

Of Fabricius, J. C. Forsøg til en Afhandling om Planternes Sygdomme. *In* Det kongelige Norske Videnskabers Selskabs Skrifter 5: 431-492. 1774.

With Introduction, Notes and Bibliography

By ERNST GRAM

Published by the AMERICAN PHYTOPATHOLOGICAL SOCIETY
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NOTICE

THE translation of Fabricius's "Forsög til en Afhandling om Planternes Sygdomme" is the first of a series of Phytopathological Classics to be issued at irregular intervals by the American Phytopathological Society. The publication of this series was authorized by the Society at its Annual Meeting at Kansas City during the Christmas Holidays, 1925. Each number will constitute an independent separately paged publication, but numbered serially. Early papers of historical or fundamental importance in the field of Plant Pathology are to be republished in this series. When in a language other than English, they will appear as translations.

A special editorial board has been authorized to select and edit this series. This board as now constituted consists of H. H. Whetzel, Ithaca, New York, Editor-in-Chief, with E. C. Stakman, St. Paul, Minnesota, and F. D. Fromme, Blacksburg, Virginia, as associate editors. Suggestions for succeeding numbers of this series are solicited.

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FABRICIUS—ATTEMPT AT A DISSERTATION ON THE DISEASES OF PLANTS

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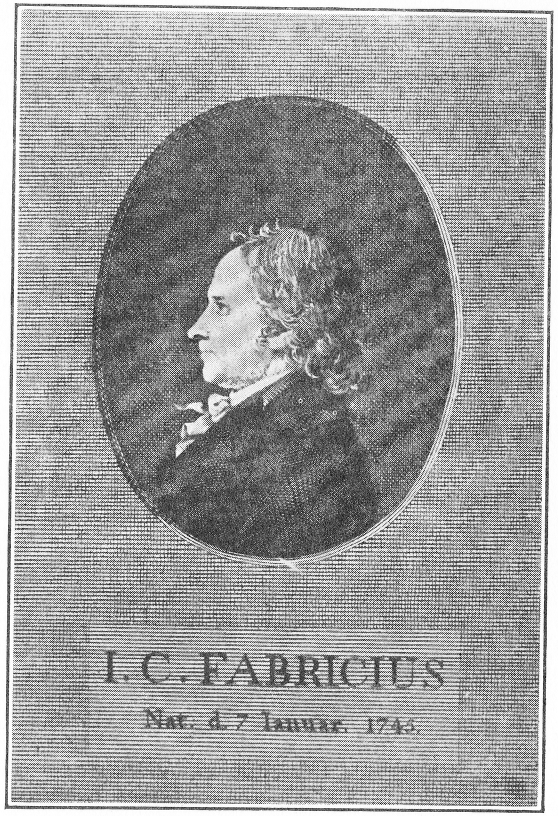

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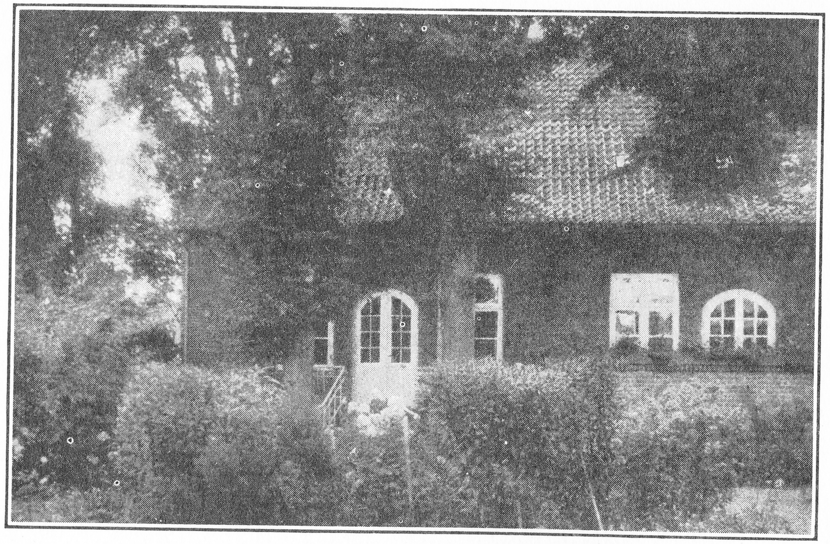

THE BIRTH PLACE OF FABRICIUS

These photographs, showing the street view and the garden of the house in which Fabricius was born January 7, 1745, were taken by Ernst Gram. In his letter of October 2, 1926, accompanying the photographs, he writes: "During a visit to Tønder, the birth place of Fabricius, I succeeded in locating the very house where his father lived and in which the babe J. C. was born. The house is well kept but otherwise as it was originally. Over the door a carved stone reads:

Jeremias XXIX. 5–7
Ann.
MDCCXLII.

INTRODUCTION

By Ernst Gram*

BORN on the 7th of January, 1745, in Tønder in the marshy district of western Schleswig, as son of a physician, Johann Christian Fabricius already in his boyhood surveyed surrounding nature with the works of *Linné* in his hand.

After high school years in Altona we find him studying, 1762–64, with Linné in Upsala, together with his relative Johan Zoëga. Of these two students Linné has left us the following testimony: "Quando Dominus "Fabricius ad me venit cum insecto et D. Zoëga cum musco, tunc ego pileum "detraho et dico: "Magistri mei estote vos" (When Mr. Fabricius turns up with an insect and Mr. Zoëga with a moss, I take my hat off saying: You are my masters). That the feelings of Fabricius towards his master were equally devoted, his quotations and letters bear sufficient witness. In the years 1765–69 Fabricius travelled through Germany, Holland, England, France, and Italy, study-

* Director of the Danish Phytopathological Station, Lyngby.

ing collections and establishing close friendships with the scientific leaders of the century. While abroad, in 1768, he was appointed professor extraordinary at the Royal Botanical Garden and the University of Copenhagen. Seven years later he was summoned to the chair of Science and Economy in Kiel, at this time still a part of Denmark. The University was small, his salary low, and the working facilities poor. Thus, in 1796 (1), he gives a logical plan of experiments, which he would have carried out—with varieties of grains and potatoes, with the influence of manure and artificial fertilizers on yield and quality, with dates of sowing, fodder crops, and cross breeding —*if* he had possessed an experimental field. Most of the year he therefore spent in extended travel, studying in the scientific centers and in the open, and writing "Travels," apparently in order to obtain funds to continue his travels. Every year he passed several months in Paris, and when his advanced ideas of evolution are considered it is apparent that in the breach with the Linnéan system of Creation, in the struggles then going on in Paris, he contributed essentially to Lamarckism and was stimulated as well.

The "Attempt at a Dissertation on the Diseases of Plants" published in 1774 in Det kongelige Norske Videnskabers Selskabs Skrifter (Acts of the R. Norwegian Academy) vol. 5, pages 431–492

(printed in Copenhagen), is an essential contribution to the early development of Phytopathology. By the elaborate system, natural to the pupil of Linné, by the copious material collected, but mostly by the critical remarks, the Attempt far exceeds its sources and contemporary writings. The combined interest of science and economics, an essential requirement for phytopathologists, a great gift of observation, and a keen power of criticism are revealed in the pages of the Attempt.

However, the ideas taken up here were crowded out by his pursuit of evolution and in particular by entomology.

His work along these lines is described fully by *C. Christensen* (4) and *K. L. Henriksen* (7).

With his great scientific gifts Fabricius combined a lovable, helpful and modest nature. He died during a visit in Copenhagen in the year 1808, his illness being seriously aggravated, it is said, from grief over the Danish disaster in the war.

Attempt at a Dissertation on the Diseases of Plants*

By

JOH. CHRIST. FABRICIUS

Translated by

MRS. MARGARET KØLPIN RAVN

KNOWLEDGE of the diseases both of animals and plants forms an important part of our rural economy, but is still too much neglected. We see our cattle fall and our plants wither away without being able to render them assistance, lacking as we do understanding of their condition. Doctors have disdained to condescend to dumb brutes and have delegated them to the mercies of horse-doctors and quacksalvers who are accustomed to use certain mixtures for all diseases without insight and without method. They are acquainted neither with the construction of the body nor the effects of cures, and are therefore unable to adapt or modify the treatment to the conditions or to the observations of the causes of

* A new Danish edition, with an introduction by Ernst Gram, appeared in Tidsskrift for Planteveal 32: 122–155, 1926.

disease. That is why our knowledge of the diseases of cattle is still very incomplete and limited. It is true that of late this science has been studied with great eagerness. France had founded her *Ecole Veterinaire* and other nations have sent thither their clever men that they might learn there the diseases of animals and their cure.

At present however, we remain in expectation of the many improvements to result therefrom, and which we at least hope for and desire.

With plants the condition is far worse; rural economy contains no complete description of their diseases. To be sure from time to time agricultural publications note the best known, though totally without system, and practically no two writers agree as to the causes of these diseases.

Many have attributed the damaged growth of their plants to the earth, the sky and the unsound air; this common refuge for the ignorance of doctors has not been forgotten in the case of plants. However the diseases of plants like those of animals seem to be due to internal causes, though indeed I recognize that the conditions of the air can sometimes aggravate the same.

I will therefore essay in this attempt to treat of the diseases of plants and their causes, briefly but systematically.

It is only an attempt, and far from complete, but I will be glad indeed, if I can encourage others

to make closer observations on this so important part of agriculture.

The classification of these various diseases is arbitrary; several could be made and for each could be found arguments for and against. Hitherto attention has been directed only to that part of the plant on which the disease is observed, yet the same disease can attack various parts of the plant; other diseases appear sometimes on one part sometimes on another, while the injury or cause of the disease lies hidden in quite other parts. I will therefore attempt a new method and deduce the classes and genera according to the apparent cases, but the species according to the causes of the disease.

Class I. *Rendering unproductive* are those cases in which the plants are prevented from setting fruit or are rendered distinctly less fruitful. This is frequently not observed until after blossoming.

Class II. *Wasting* are those cases in which the plants are slowly killed, their growth and strength gradually decreasing.

Class III. *Decaying* are those cases in which the main parts of the plants are decomposed and become a rotting mass, which by degrees is transformed to mouldy soil.

Class IV. *Discharging* are those cases showing an abnormal flow.

Class V. *Rendering misshapen,* recognized by the abnormal development of the external parts.

Class VI. *Extraneous* are those cases due to the apparent injury to the parts.

CLASS I

Rendering Unproductive

GENUS I. Super-abundance of sap.
Polysarkia

Super-abundance of sap is really an indication of great health in both animals and plants; however in the latter it sometimes occasions an unfertility, wherefore it must be grouped among the diseases. Too abundant sap is easily recognized from the great number of shoots and leaves, while of blossoms and fruit the plant sets only a few or none at all. This is very often observed on fruit trees in the gardens of those plant lovers who, disregarding the nature of their trees, believe that the soil can never be rich enough, and the disappointment to their hopes is the more bitter in that it was at first nourished by the luxuriant growth of the trees. This disease, too, is sometimes found on cereals, though seldom, and only on sturdy

plants, which, though too abundant fertilization has encouraged the growth of straw and head, yet yield a smaller number of seeds. The cause of this disease is to be found in the too abundant flow of the life-giving sap which renders wood and bark too strong. The internal, marrow-like part of the plant, which is sundered at blossoming, is unable to combat the opposition of the sturdy external parts, and therefore unable to develop into flowers and fruit. (*Cf. Linn. Dissert. Prolepsis Plantarum.*) This is why well-developed branches never bear fruit, while the weaker ones do so constantly, and why gardeners set those plants which they desire to produce blossoms in small pots in a warm place. The scanty nourishment allowed hinders the development of the external parts, whereas the warmth stimulates the development of the internal parts, enabling them the more easily to sunder the external parts and blossom forth.

We have various remedies for this disease. It is possible to reduce the resulting unfertility by extensive pruning of the woody parts; however this does not remove the cause of disease. Another remedy is to replant or to place other soil about the roots, or again, to remove a section of the large vertical tap-root, thus diminishing the supply of life-giving sap.

Smut on cereals is one of the most common and best known diseases; it often nullifies all hope of a good harvest. It attacks by preference wheat, barley and oats, while rye and millet seldom or never suffer. Eradicating this disease has become the more difficult after recent careful investigations have proved it contagious. When it has once gained the upper hand in a field, it increases in strength year by year. We are indeed unable to cleanse our fields of it unless we resow them with clean, fresh seed. This disease is still to be found on several of our wild grasses, especially *Panicum miliaceum* (Schwaden), *Triticum repens,* cock's-foot grass, and a few others.

Smut only attacks the floral structures which it gradually transforms to a loose black powder easily blown about by the wind. While the plant is germinating and growing no traces of the disease are observed, but as soon as it heads, smut attacks the tender parts of the kernel and changes them to that black powder, especially noticeable when the grain is threshed, for it flies about everywhere. Moreover the disease so substantially decreases the number of the kernels that in many fields more smutted than healthy grains are found.

Much care has been expended in a closer study of the causes of so destructive a disease, hoping

thus to find means for its prevention; hitherto no consensus of opinion has been reached. Tillet claims, in a paper which won the prize offered by *l'Academie Francaise* for this subject, that smut is spread by contagion alone. In this he only upholds our own opinions in regard to its contagious qualities without showing the real causes. If we were told that contagion was the cause of cattle disease, would we be expected to believe that a new and important discovery had been made? Every farmer knows that cattle disease and smut both spread because they are contagious; what we wish to know are the actual reasons for the cases of diseased cattle and smutted grain.

Professor Gleditsch, on the other hand, attempts, in an extensive and diffuse treatise, included in his physical botanical papers, to prove that those kernels which have not attained full maturity at harvest time, undergo, in their place of storage, a kind of fermentation, from which later, when the seed is sown, smut is derived. He quotes some examples which seem to prove his point, yet even so, much doubt remains. How can it be that it is contagious when true smutted heads yield no kernels able to spread fermentation? How can it be that no smut is observed the first season after fresh seed has been sown? We may hardly assume that the kernels attain greater maturity during these seasons. How can it be that only a few

species of plants are attacked by smut even though undeveloped seed are to be found in all. Rye, millet, and many other cereals and grasses are very seldom or never attacked by smut even though the bad weather of autumn obliges us to reap early. Should seed which has not ripened properly, and therefore undergone a kind of fermentation, not give the slightest sign of injury during its development until it heads? This is hardly to be expected of half-spoiled seed.

Herr von Mynchhausen in the first part of his "Advice to Householders," and von Linné (Knight) in a *Dissert. Mundis invisibilis,* claim that when the black smut powder has soaked in water for some days it is dissolved into small worms, and these they believe are the true cause of smut. A kind of movement is always observable when the black powder has been saturated; whether this is due to something animal, to something organic, or whether indeed it is the cause and not the effect of the smut, is not absolutely certain. However, certain it is that the cases and symptoms of smut can never be better explained than by assuming something organized to be the cause.

Many authors describe still another kind of smut, the so-called stone-smut, but with this I am not sufficiently acquainted. Cereals attacked by

this are said to become black, hard and shiny. This would seem to indicate that it is a species of the real smut.

Two remedies are used to prevent smut on our fields: sowing pure seed, and soaking the seed in a solution of salt or lime. Both remedies are highly praised and indicate, moreover, that the cause of smut is not to be sought in the soil but in the seed.

Genus III. Barrenness. *Aurigo*

Barrenness is that disease of plants due to which, even though the plants blossom, they, after blossoming, show not the slightest sign of setting fruit. We observe the phenomenon annually and frequently, both in our fields of cereals and in our gardens and orchards. Sometimes our plants suffer more from this than from smut, though it is less conspicuous. The straw grows well and abundantly, but the heads point directly upwards, indicating that they are lighter than the normal heads and therefore contain less kernel. Sometimes the entire head is attacked by the disease and it then consists of empty hulls; sometimes we find empty hulls and full hulls side by side, but we seldom find a head in which every hull contains a kernel.

The common cause of this disease lies in inhibited fructification. The different sexes of plants

have already been sufficiently demonstrated, but it is there we must seek for the cause of barrenness. If the pollen of the male flower is entirely lacking, or rendered ineffective, or prevented from falling on the moist *stigma* of the female flower, no fructification occurs, the blossom falls off without showing the slightest sign of fruit. We find many species of this disease, because the causes preventing fructification differ.

1st Species: *Barrenness due to rain.* Too persistent rainfall is the usual cause of barrenness in our Northern countries. We lie low for the most part, surrounded by high mountains, therefore the weather here is, as a rule, variable and damp. If during blossom-time constant rain sets in, the rain makes the pollen moist, heavy, ill-adapted to flying about and so to fructification.

2nd Species: *Barrenness due to cold.* Our Northern countries are also frequently subject to this disease. Actual winter cold very seldom or never inflicts suffering on plants, for at that season all growth ceases entirely and the cold is seldom severe enough to split the trees asunder. However in the spring, and sometimes far into the year, the incipient warm weather is often broken by frosty nights from which the plants suffer the more. During the months of March and April we often see our fruit trees and other plants full of blossoms and filling us with the sweetest

hopes for a rich harvest; a single frosty night and the hopes are utterly destroyed. In barrenness due to rain the seat of disease is the pollen, in the present case it is to be found in the parts of the female flowers, for when cold has caused the moisture-filled vessels of the stigma to expand, they explode and are thus rendered unfit for fructification.

3rd Species: *Barrenness due to smoke.* Smoke is very detrimental to the fructification of plants, for it dries up the liquid in the stigma necessary to fructification. I once observed a splendid example of this disease in Germany in a wheat field. In one end of the field some tramps had camped out while the corn was in blossom. The field was beautiful, with large, full heads, only in the path where the smoke had drifted across were the heads empty.

4th Species: *Barrenness of bastardized plants.* Bastardized plants is the name we give to those which spring from the crossing between two different plants; they are the same among plants, as are mules among animals. They are not propagated by seed, yet occasionally by root as *Peloria Linnaei.* The cause of their unproductiveness seems to lie partly in the lack and partly in the consistency of the pollen of the male flowers. See Koelreuter's "Experiments and Observations on the Sex of Plants."

5th Species: *Barrenness due to lack of male flowers* is to be found in part among the so-called dioecious plants (*plantis dioicis*), of which the immortal von Linné (Knight) gives many examples in proof of the sex of plants. The female flowers blossom perfectly, but they wither without the slightest indication of fruit if no male flowers are to be found in their vicinity to fertilize them. This disease is also to be found among monoecious plants (*plantis monoicis*), in gardens, melons for instance, cucumbers and others from which gardeners, under too thorough pruning, remove the male flowers, thus preventing the fertilization of the female flowers.

6th Species: *Barrenness due to lack of motion.* This is found more often than one might believe. Plants enclosed in greenhouses often bear no seed, and the above seems to me the reason for that kind of barrenness. A certain amount of circulation of air is necessary, especially for *Dioicis,* to scatter the pollen and the greater the force with which the pollen falls on the *stigma,* the more complete is the fertilization. Insects, bees and others which work in the flowers are often substitutes for this lack of motion and I do not in the least doubt but that they are absolutely necessary for the fertilization of those plants in which the perianth closely covers the organs of fertilization.

Genus IV. Unseasonable Deciduity. *Abortus*

Unseasonable deciduity is the name we give to that disease of plants under which, even though the flowers are fertilized, the fruit withers and falls off before reaching maturity. We find many examples on cereals in which the kernels are set but dry up in their hulls. The straw develops well but the heads are light, and when the hull is opened only a small unripe kernel is to be found containing no flower. Fruit-trees in orchards are likewise subject to this disease; the fruit that is set dries up without apparent external injury and falls off. This disease does not hinder the growth of the trees but the fruit of that summer is lost.

The cause of deciduity lies either in the lack of nutritive sap or in the prevention of its flow. The plant is unable to nourish the fruit set; this gradually dries up and falls off. As many circumstances contribute to this lack of nutritive sap or to its lack of effectiveness, many species of the disease are observed.

1st Species: *Deciduity on young plants.* The disease is very prevalent on young and growing trees; these blossom abundantly but are incapable of bringing all the fruit set to maturity, and therefore allow them to fall off unripe. The more abundantly a tree blossoms, the greater is the drain on the nutritive sap and the smaller the quantity of fruit reaching maturity. Careful

gardeners, then, remove some of the blossoms and thus secure a greater quantity of fully developed fruit, and also thus prevent the young trees from exhaustion.

2nd Species: *Deciduity due to drought.* A severe and long-continued drought greatly diminishes the moisture in fields, and the plant nourishment actually present in the fields is prevented from penetrating into their fine vessels. The straw of cereals becomes yellowish, the heads light; when the hulls are opened, undeveloped kernels are found.

On grass varieties and mosses which wither completely during dry weather and freshen again under the slightest rainfall, this disease is very apparent. Large plants on the contrary, with roots deep in the soil, do not so readily risk deciduity due to want of moisture, for, penetrating as they do so much deeper into the earth, moisture is not lacking.

3rd Species: *Deciduity due to cold.* If a heavy frost occurs after the fruit is set, the chill splits the vessels swollen with moisture which are to lead the nourishment to the fruit, and the fruit rots and falls off. This disease is often observed on fruit trees, which, for the sake of warmth, are planted near walls, for they always blossom and set fruit early.

4th Species: *Deciduity due to lack of nourishment.* This form is often observed on our sandy, unfertile fields. They are sown annually but the fertility found in the soil is insufficient to bring the kernels to maturity.

5th Species: *Deciduity due to injury of the stalk.* When the straw of cereals is broken by external injury, though not entirely torn away, the vessels are so compressed that the sap can no longer flow in as great quantities as before and the grain already set diminishes and fails to attain the necessary degree of maturity and perfection. This is why heavy gales, violent rain and hail do so much damage to our fields of cereals.

6th Species: *Deciduity due to the sting of insects.* Our plants suffer most from the sting of insects. These we do not so often see because they are so small, however their almost countless hordes and turbulent fecundity quite compensate for their small size. They are often the cause of the above disease. They bite a hole in the fruit and suck nourishment, finally causing the fruit to dry up. We can often see such dry fruit hanging on trees and for this, insects only are to blame. The Knight Linné computes the damage done by *Oscinis frit* on barley alone at a very large sum.

Genus V. Doubling. *Plenitudo*

Doubling of flowers occurs when the perianths increase, thereby preventing the formation of the

internal parts essential to the flowers. In this way the stamens are either pushed entirely aside and the flowers become barren, as fertilization cannot occur or the perianths by their increase push the stamens partly aside, in which cases fertilization occurs but occasionally. The care taken under forcing and the super-abundance of nutritive sap are the real cause of double flowers. Our horticulturists use all their arts in their attempts to produce these and to make them ever larger and more beautiful. This is the triumph of horticultural skill, as the high price asked for these double flowers and their magnificent but not sufficiently characteristic names, indicate. Sometimes, but indeed seldom, we observe doubling on fruit trees and on wild plants which is our reason for grouping it under plant diseases.

1st Species: *Doubling due to increase of the external perianths.* This form of doubling is rarely seen, nor does it seem to injure the fertility of the plants.

2nd Species: *Doubling due to the increase of the internal perianths.* This is the most common form of disease. Roses, hyacinths and anemones present many cases in which, due to the increase of the petals, the stamens are entirely shut out and therefore barren. Other flowers, the monopetalous, *Flores monopetali,* for instance, double only the internal perianths without excluding the

stamens and therefore often run to seed. Flower specialists designate the former group, "double flowers," (*Flores pleni*), the latter, "enlarged flowers," (*Flores multiplicati*). Finally another form is found in which a new stalk grows from the double flowers; this develops, forming partly leaves, partly flowers. This sometimes occurs on roses and also in the double daisy, (Bellis), and is known as "proliferate flowers," (*Flores proliferi*).

3rd Species: *Doubling due to the increase of the honey vessels,* (*Nectaria*). This form has only been observed on a few plants. Sir Linné, in his *Philosophia botanica,* page 83, notes this form of doubling on *Nigella* and *Aquilegia,* where sometimes the increase of the honey-vessels shuts out the internal perianth, and sometimes the perianth remains, the honey-vessels, however, increasing in size and uniting between the petals.

4th Species: *Doubling due to the enlargement of the internal perianths.* This form is observed on many plants which bear two kinds of flowers, *viz.*: fertile, with a very small perianth inclosed by others which are barren, *Flores composita* (composite flowers). *Viburnum Opulus* and others are examples in which doubling consists in the internal, fertile flowers assuming the form, size and barrenness of the external flowers.

CLASS II

Wasting

GENUS I. Choking. *Suffocatio. Etiolement Adans. Famil. des Plant.,* I., 48 (2)

Choking is recognized from the scrawny, puny appearance of the plants attacked, their long, dry twigs and their scanty yellow leaves; the more this disease gains the ascendancy, the paler the color of the plants becomes, until at last they dry up without bearing fruit. The cause of the disease is to be sought in the lack of circulation of air without which neither plants nor animals can exist. Both need to perspire in pure healthful air, which is in motion since this increases perspiration; this is the reason for the unhealthy condition both of people and plants confined to foggy places as their color indicates. The disease is likewise observed on *Zoophytes,* the connecting link between the animal and the vegetable kingdom. These are destined to grow at a certain depth below the surface of the water, where the external motion of wind and wave cannot penetrate, therefore their flowers are endowed with a spontaneous motion without which they could not exist.

1st Species: *Choking due to confinement of locality.* This form of the disease is often observed on young trees surrounded on all sides by others of tall growth. They grow straight with

long weakly shoots until their tops are on the level with the tops of the surrounding trees and they can then enjoy the effects of the free air. If they have not sufficient strength to attain this height they gradually wither away from sheer lack of air and exercise. Sensible gardeners are cognizant of this disease and seek to prevent it by thinning out among the trees which stand too close.

2nd Species: *Choking due to lack of light.* I do not know what light does to further the growth of plants, but experience proves that it is a factor necessary to their development. For this reason in greenhouses those plants furthest removed from the windows are the weakest, also the plants which are artificially forced during the winter have a pale yellow color, the more they are forced, the paler they are, and the weaker their perfume, and further, plants growing in dense forests, even those native to such places, are always of a sickly, yellow color and never have the bright appearance of other plants.

3rd Species: *Choking due to trailing plants.* Among our noxious species of weeds are some which, with their long slender vines, bind plants together, prevent their motion and completely choke them. To these belong the so-called dodder (*Cuscuta*), and bindweed (*Convolvulus*), which are often a nuisance in gardens, for thick stems and large leaves require free movement.

4th Species: *Choking due to insects.* This, according to the testimony of Sir Linné, the Knight, is the form of the disease most often observed in greenhouses. It originates on *Acouo telario Linnaei,* which draws very tiny, hardly perceptible threads across leaves of plants; these become yellow and finally fall off.

Genus II. Decline. *Tabes. Jaunisse Adans. Famille des Plantes,* I., 48 (2)

Decline is the form of disease under which plants gradually lose their fresh appearance, their growth decreases and they finally wither away. In the earliest stages of disease, the leaves are limp, later they dry up. The stalk begins to show a yellowish color and at last the whole plant dies. This disease often attacks a part of a plant only, a single branch; and then, as a rule, the tree may be saved if the diseased part is sawed off and destroyed.

The cause of the disease is to be sought in inhibited circulation of the small amount of nutritive sap necessary for nourishing the plant. As soon as a part or the entire plant lacks its required nourishment, it suffers, presents a sickly appearance and finally dies. It may show green leaves for a certain period, but these are, as a rule, covered by a horde of plant lice which soon drain the remaining strength of the leaves.

1st Species: *Decline due to lack of nourishment.* Soil nourishes plants just as long as it contains the necessary nutritive substances. When these are exhausted, either because the plant growth is too dense or because the soil is naturally poor, the roots can no longer take up nourishment and the plants decline and die. Our poor and sandy fields, and the plants growing on scanty soil among stones, present sufficient examples of this disease.

2nd Species: *Decline due to unsuitable soil.* Nature has provided special foods for animals, and diverse soils for plants, in order that one shall not thrust aside nor overwhelm another. If plants are removed from this soil and placed in one unsuited to their character, they are not always able to adapt the juices to their use. They grow weaker each year and are covered by so many plant lice that they are finally totally destroyed and leave no trace whatever of their presence. Many examples of this disease are to be observed in the gardens of the ignorant; moreover the various mixtures which horticulturists use in watering their gardens often cause decline.

3rd Species: *Decline due to injury to the parts.* As soon as those parts which the plants use in absorbing nourishment are injured, decline at once sets in. A typical example is the injury to the roots due to the activity of the root worm so often observed in our meadows.

4th Species: *Decline due to evaporation after transplantation.* Newly transplanted plants are not immediately capable of absorbing as much nourishment as the evaporation in the severe heat of summer requires; we therefore often see them wither after transplantation. This is why skillful gardeners always transplant in cloudy or rainy weather, or at any rate secure shade for the plants.

5th Species: *Decline due to premature shedding of the leaves.* Most of our plants shed their leaves in the autumn, but until that time they are necessary to the trees. If shed sooner, the trees suffer and often die, as those trees bear witness which are deprived of their leaves in the spring by the cockchafers, or the mulberry trees which are too greedily stripped of their leaves to furnish food for silkworms.

6th Species: *Decline due to discharge.* When secretion of the resinous parts is too copious, decline often ensues, because a large part of the nutritive sap has thereby been lost. This form of disease is often observed on young spruce and pine trees after too eager collectors of resin have made too many and too deep incisions in the bark. See Genus I under Class III.

7th Species: *Decline due to bleeding.* Bleeding is a natural characteristic of many plants; however if these watery secretions are too copious,

due to some external injury, decline often results. This form of the disease is often observed on grape-vines pruned at the wrong season, also on birch trees which have been tapped.

8th Species: *Decline due to parasitic plants.* We call those plants parasites which plunge their roots deep into the substance of other plants and draw therefrom nourishment to themselves. Plants suffer much from these parasitic guests. When the latter propagate too abundantly, a decline ensues which can prove mortal for them both.

CLASS III

Genus I. Discharge. *Extravasatio. Depot Adans. Famil. des Plant.,* I., 49 (2)

Discharge consists of the secretion of a slimy liquid through the bark; this thickens as soon as it comes into contact with the air and finally hardens. The sap thus secreted can either be dissolved in water and is then known as gum, or it can be dissolved in various kinds of spirits and is known as resins. These in turn vary according to the different species of trees which have produced them and are used both as medicaments and incense. We seek, therefore, by artificial means to propagate this disease in order to obtain the various secretions in greater amounts. We cut incisions in the bark in the spring, and in the

autumn we gather the coagulated sap. However the growth of the trees always suffers more or less under the treatment; if we cut too many, or too deep incisions, they fall into a decline and wither away. This disease is due to the bursting of the vessels of secretion; in this it may be compared with the various kinds of bloody discharge known in animals, and which, though sometimes beneficial to health, yet always occasion a bodily weakness. Nature expends a large part of her forces in compensation for this injury, which only results in the discharge becoming more and more copious. However it is seldom that the natural secretion of plants is so great that remedies become necessary. The best treatment is to prune away the injured part and bind the sore with tree wax.

1st Species: *Discharge due to injury to the bark.* This disease may appear whenever the bark is injured, whether the injury is due to accident or intention. The greater the injury, the more copious the discharge.

2nd Species: *Discharge due to abundance of sap.* The quantity of juices is sometimes so great that the vessels are unable to contain it all. These enlarge as much as the parts permit, and then burst; the discharge is then apparent.

3rd Species: *Discharge due to the tartness of the sap.* Saps and juices of plants, like those of

animals, are sometimes so pungent that they eat up the vessels of secretion and then overflow. Plants growing near muddy water often have a discharge due to this cause.

Genus II. Lachrymation. *Lacrymatio*

Lachrymation consists of the secretion of a watery fluid from the eyes. This disease is quite unlike the preceding one, for in this the nutritive sap flows out through the eyes or through the vessels of the tree, while in the former the sap belonging to each plant flows out through the vessels of the bark. Therefore they differ both in respect to the place from which the fluid comes, and in the fluid itself. This lachrymation is not observable on all plants. It is characteristic of a few only,—the grape-vine, the birch tree, the maple tree and some willows. It is not always present, but in the spring, when the sap begins to rise, it is most generally observed. It is therefore a general rule among horticulturists that those plants which are subject to lachrymation should not be pruned at all in the spring, or in any case only lightly, thus preventing their being weakened by the ensuing copious discharge. The correct season for pruning is the autumn, or very early in the spring, before the sap has begun to flow. A hole is bored through the bark of birch trees and maple trees and of the palm trees of

India, thus encouraging the discharge, which is known variously as birch water, maple syrup, palm wine. The trees however suffer from the treatment.

1st Species: *Natural lachrymation.* In the spring some trees shed tears (bleed) through their eyes, but this is more an innate characteristic of the variety than an actual disease. This natural lachrymation has no evil after-effects, for it is rarely copious enough to weaken the trees. However the more abundant their nourishment and the more super-abundant their nutritive sap, the more copious the lachrymation. Later, when the leaves develop, this ceases of itself.

2nd Species: *Lachrymation due to external injury.* There is no better way of improving a tree than by judicious pruning. On the other hand if trees are pruned in the spring, or sustain an injury which penetrates to the wood after the sap has begun to ascend, copious lachrymation ensues, the tree is weakened and finally goes into a decline.

Genus III. Honey-dew. *Erysiphe, Le Givre Adans.,* I., 45 (2)

Honey-dew is the secretion of a thick, slimy liquid on the surface of the leaves. Plants attacked by this disease have large shiny spots on the leaves which, when the attack is severe, run

into one another and drip; however they are soon dried up and scorched by the heat of the sun. The attack is generally worse in the cool of the evening, and plants suffering from this disease are often destroyed in one night. They are permanently weakened, bear tasteless fruit or none at all. Honey-dew is the most common and malignant disease of hops. It can destroy an entire hop plantation in a single night. Much pains have been taken to discover the true cause of this pernicious disease,—as yet naturalists differ. Some claim that honey-dew, like other dew, only falls when certain winds prevail, which is why it is called dew; however this opinion is at odds with the nature of dew and with the circumstances attendant on honey-dew. Dew which is common to all animals and plants is never of so harmful a character that it is responsible for the destruction of an entire neighborhood. However honey-dew attacks only certain species of plants, and that, too, not all the plants of the same species. We observe a hop field reeking with honey-dew, yet the adjacent plants are untouched and what is still more surprising, the same is true of certain other plants in that field. The weakened condition of the plants after the attack indicates that some of their sap must have mixed with the honey-dew.

Adanson, in his *Famille des Plantes* (2), gives inhibited evaporation, due to the lack of pure

fresh air, as the cause of honey-dew. We are familiar with other diseases which are caused by lack of circulation and evaporation; however the circumstances attendant on honey-dew differ so greatly from those due to inhibited evaporation that I am unable to concede this as the cause of honey-dew,—especially in view of the fact that the great quantity of sap secreted seems rather to indicate a too abundant than an inhibited evaporation. Others believe that the disease is caused by plant lice and snails which are present in hordes on the diseased plants. This seems to me rather a result than a cause of the disease. Insects and snails find pleasure in the sweetish juice which has been secreted and come from all the adjacent plants to suck it.

Linné, the Knight, in his "Journey to Skaane," gives another and very different cause of the disease. He believes it to be due to the larvae of *Phalenae Humuli,* which attack the roots of hop plants, and he claims to have caused the disease by depositing the eggs of that nightly visitant about the roots of hops. It seems reasonable to believe that the disease is occasioned by injury to the internal parts necessary to the life of the plant. The art of medicine teaches us that those suffering from injury to the internal vital parts lose all their strength in heavy nightly sweats. May not a resemblance be found between such

nightly sweats and honey-dew? Injury to the root occasions poor nutrition with a resulting weakness of the entire plant which at last develops into honey-dew. Yet it is very strange that this honey-dew generally appears in a single night and disappears again just as quickly without a single sign being visible either before or after the attack.

Various remedies have been tried for this disease, depending on the cause to which it is attributed. One in particular is described in the Agricultural Archives, No. XX, p. 712, and I have requested a detailed account of the results obtained (12). This remedy consists in the application of pig manure as fertilizer. We know that pig manure is the most effective remedy for insect pests, and when, as in this case, the remedy is found efficacious, it seems to be a strong proof that insects are the cause of the disease.

CLASS IV

Decaying

Genus I. Rot. *Caries. Pourriture* *Adans.,* I., 50 (2)

Rot consists of decay of the woody portions of the stem (trunk), and their gradual transformation into mouldy soil. This disease usually begins from without, gradually spreading until the entire tree is hollow, only the bark being left, filled with

a soft, rich mould from the rotten tree. Willows are particularly susceptible to this disease and we often find that nothing remains except the outer bark, yet the shoots annually put forth green leaves. Insects, especially *Dermestes* and *Cerambyx,* contribute much to the destruction of the tree. As soon as a portion of the wood is rotted, they bore into it in all directions, giving the dampness access, and furthering the process of decay. The cause of the disease is the inhibition of the flow of sap which then becomes pungent, attacking and destroying the hard portions of the tree. Every static fluid, whether contained in the nutritive vessels themselves, or penetrating to them from without, has the power of causing such rot.

1st Species: *Rot due to the accumulation of rainfall.* Nature intends the bark to keep out air, moisture and rain. If the outer bark is injured, or if a branch is cut off so that rain water can collect in the wound and act on the woody portions of the trees then this stagnant water, and the pungency it contains, will cause rot. This is why gardeners so carefully treat wounds on trees, and the stumps where branches have been lopped off, with wax, thus preventing the action of air and water.

2nd Species: *Rot due to the stoppage of the nutritive sap.* This sap possesses the same characteristics as the other fluids; when circulation is

prevented it becomes pungent and attacks the adjacent parts. Therefore when the nutritive sap is super-abundant and its flow is checked, the tree soon rots. This is often observed on willows whose branches have been lopped off. The sap which hitherto flowed through these branches cannot immediately readjust itself; it becomes choked and causes rot, even though the trunk is very carefully protected from the air and the internal juices. The only sure method of treating rot is to cut out the injured parts, and, in so far as is possible, with a vertical cut, afterwards sealing the surfaces thoroughly with tree wax to keep out dampness.

Genus II. Putrefaction. *Putredo*

Putrefaction is the decomposition and decay of the soft parts which are gradually transformed to a slimy, muddy substance. This disease either attacks the roots, and in that case the entire plant dies at once, as its nutrition is cut off, or it attacks unripe fruits, as we often observe in fleshy fruits and cereals.

The cause lies presumably in a super-abundant and suspended fluid which attacks the adjacent parts until they ferment and become mouldy. External conditions, damp weather for instance, add their contribution, and in wet seasons we are witness to the way in which mould spreads over our fields and orchards.

1st Species: *Putrefaction due to too rich soil.* All plants require their own special kind of soil; if we give them one which is richer or fatter than the one where they are accustomed to grow, they often suffer from this disease. The sap flows in greater quantities than is necessary for nourishing the plants, it is therefore stopped in the various vessels, becomes pungent and destroys them. This is often experienced by flower lovers who plant carnations and set their bulbs in soil which is too well fertilized, in the hope of attaining larger and more beautiful blossoms, but of these the larger parts moulder away.

2nd Species: *Putrefaction due to too much fluid.* Any suspended fluid, either sap or rainfall, causes this disease. It is observed on plants in flower-pots with no holes in the bottom through which the water can be drained off but which, nevertheless, are daily watered thoroughly. The soil becomes sour, moss grows on the surface and the plants rot. Cereals sown in the field suffer from dampness, especially in our climate, when sown too late in the autumn, after the wet weather has set in.

This disease is found on soft fruits, especially cherries, and on certain of our cereals too, for that matter. Super-abundant moisture causes them to mould on the stem before attaining maturity.

3rd Species: *Putrefaction due to external injury.* When the external parts, root or fruit, are

injured, moisture gains admittance the more easily and causes the disease.

4th Species: *Putrefaction due to parasites, cited by Duhamel in Act. Parisiens. on saffron* (5). In the same article he describes a fungous growth which attacks the knobby roots of saffron, changing them to a mouldy, rotting mass.

Genus III. Canker. *Cancer Adans.*, I., 52 (2)

Canker is characterized by large protuberances or growths on the trunk (stem) which constantly, even at the dryest time of the year, exude a corroding juice which attacks the adjacent parts. Trees often suffer very much from this disease, and I have seen gardens, especially in our low, damp marshes, where almost all the trees were attacked. They wither, and finally, when the disease has penetrated to the internal parts, dry up entirely. The cause of the disease is to be sought in deranged nutritive sap which in the end becomes pungent and rotten and eats into the adjacent parts. The more rotten the sap, the more quickly and completely does it attack the tree.

I do not know more than one variety of this disease due to rotten, putrid water. The poison of the water enters the nutritive sap, which, in turn, gradually eats into the vessels and causes the disease. A few years ago I saw with my own

eyes a quince tree planted in a low place into which an adjacent manure heap drained. This caused a very severe attack of canker on the tree, though no other plant in the entire garden was affected by the disease.

Adanson (2), in his pamphlet referred to above, tells of another species of this disease, namely, one in which the noxious secretion does not exude, but remains between the wood and bark. Even the strongest trees wither when attacked, without showing the slightest indication of any secretion of pungent juices. They retain their dry, withered leaves and when hewn, the noxious secretion is found between the wood and the bark.

The only sure remedy for the disease is to cut out the entire protuberance. In this way the noxious secretion is withdrawn. However the cause of deranged nutritive sap must also be removed, otherwise the disease will soon return.

Genus IV. Rust. *Rubico. Rouille*

Duhamel: Elem. d'Agriculture, Tom. I (6)

Rust appears both on the stem and on the leaves of plants; it rends the tender covering and hides the surface under a brownish and light powder. Often it only occasions small spots on the leaves and affects the development of the plant but slightly. However, when it gains the upper hand

and attacks the stem, the plant suffers greatly; sometimes dries out entirely.

Rust is found on many plants, especially on wheat and rye in the fields; the straw splits and pours out the brown powder. In our northern climes the disease is less common and of lesser importance than in Southern Europe, where it often totally destroys all hope of a rich harvest.

Rust seems to me to bear much resemblance to smut. Smut transforms the organs of fructification to a black powder; rust transforms the parts below the epidermis or outer covering to a brown powder,—the greatest difference between the two cases appears to lie in the place in which they are found. At all events I believe that the cause of both these diseases is one and the same. The author of a small paper on rust on cereals attributes this to insects, although his paper contains no proof of his theory. Insects often cause very material injury, yet because these insects are so tiny they are not always observed; however this is no reason for denying the injury. Mind and imagination are captivated by small and great alike, for in each, nature is infinite. Meanwhile more time and the diligent research of our successors are necessary to discover the cause of both these diseases.

As remedies for rust the farmers suggest the same as used for smut,—a change of seed and

soaking the seed in a salt or lime solution prior to sowing.

CLASS V

Injury

Genus I. Fissures. *Fissura. Jerses*
Adans., I., 45 (2)

Fissures mean that either the outer bark of the tree, or the internal wood itself is split lengthwise. The first class is easily recognized as the damage itself is visible, the second, in connection with which we often hear a strong rustling in the uneven bulges of the bark is due to the difference in the length of the wood at the point of injury. Neither the fissures of the wood nor of the bark ever heal but grow longer and longer and render the wood unsuitable to carpentry.

The cause of fissures is an enlargement of the internal parts to such an extent that the external cover can no longer protect them, but splits. We often see the disease on young trees of rapid growth whose vessels are swollen by abundant moisture.

1st Species: *Fissures due to cold.* Cold as well as heat expands bodies; therefore after a very severe winter our trees split lengthwise with a loud report. However this disease is not very common and the frost must be very severe before

it causes the injury. In gardens in which foreign varieties of trees are exposed to a certain degree of cold we attempt to prevent the disease by placing manure about the roots or binding straw about the trunk.

2nd Species: *Fissures due to abundance of sap.* Too great flow or super-abundance of sap may also cause fissures on trees, especially when protracted hot weather has expanded the juices. It is true that due to the flow of sap the bark becomes more pliable and stretches very considerably, but on trees growing on soil that is too rich this expansion is not sufficient to prevent the disease and the bark and wood finally split. The only way to prevent the disease is to remove the super-abundance of sap which is its cause.

Genus II. Galls. *Gall*
Adans., I., 47 (2)

Galls is the name applied to knobs and excrescences due to the stings of various insects. We find them on all parts of plants, the only differences being their appearance, size and location. They often attain considerable magnitude and assume strange forms which attract the eye of the scientist. We see for instance so-called gall-apples on oaks, while the Bedeguar on rose bushes and the large knots, or Tophi, on the trunks of

trees seem also, to have insects to thank for their presence.

The sting of insects is, then, the cause of galls; they lay their eggs in a wound located somewhere on the plant; this wound cannot heal as long as it contains a foreign substance. The maggots creeping out finally devour the adjacent vessels and suck nourishment from their nutritive sap whose flow is increased, nature wishing to drive out what it extraneous. At last the nutritive sap increases in these unnatural protuberances which continue to grow as long as the maggots gnaw the adjacent vessels of secretion. *Linn. Cynips* is the actual noxious insect, and each species causes a different gall-form.

The so-called ergot (Clavus) is no other than a form of this disease. It comes about in a similar way: *Thrips Physapus Linn.* attacking the tender rye kernels and laying its eggs in them, the kernels develop over the husk, become blackish, lumpy, internally fungous and containing a rotten, brownish powder. The same is observed on the flowers of *Lotus corniculatus* and *Cerastium,* but on no other cereals, rye alone excepted. Many doctors have claimed that this ergot is the cause of cattle-disease (*Raphania Linnaei*); however experience proves that this is not so. In various districts of Holstein, children hunt out these kernels and eat them in great quantities without ever

being attacked by this disease, and I am sure that no one can consume such quantities in bread as these children do when eating them alone. The latest report from physicians seems to admit the same.

Genus III. Monstrosities. *Monstrositas*

Monstrosity is the name given to the abnormal growth of plants or of a part of a plant. It is often due to the manner of cultivation, and we therefore often find these monstrosities in gardens where, the more deformed and unnatural they are, the more highly they are considered. To this class belongs tulips with the large blossoms and jagged petals, here too, the variously formed roots and stems, the curled and variegated leaves which are no other than monstrosities brought about by art or chance.

However, we must distinguish between these growths and doubling (or double flowers), which multiplies some parts of the flower to the exclusion of others, thus rendering it sterile. Monstrosities, indeed, often bear seed as they neither increase nor decrease the parts of the plant, but merely give the ordinary parts an extraordinary and strange form.

The cause of the disease lies either in a too great abundance or a misapplication of the nutritive sap, by which the parts are enlarged or changed. The method of cultivation, replanting and warmth, are the usual sources of the disease.

A change in the methods can bring back the original form.

1st Species: *Monstrosity due to abundance of sap* is the most common form of the disease. The plants grow in too rich soil, and are given too great care.

2nd Species: *Monstrosity due to heat.* Change of region, variation of heat and cold exert great influence on the various changes in plants. Large fruits result herefrom, woolly (hairy), and perhaps too, the variegated leaves. Climate seems to have a special effect on size, taste, hairiness and color.

3rd Species: *Monstrosity due to external injury.* External injury is generally responsible for the bent, crooked, deformed and connate plants. The greater the injury the more deformed the plant as a rule becomes, provided of course it does not actually die.

4th Species: *Monstrosity due to a wrong pollination.* Crossing various plants under pollination usually results in forms totally different from all the others. However, as the majority of these are non-productive, they are unable to reproduce themselves.

Genus IV. Deformity. *Mutilatio*

Deformity means either that the plants are totally lacking one of their natural parts or else that it is small and imperfectly developed. It differs from doubling in that although in that disease, parts may be wanting, they are replaced or superseded by others; in the case of the deformed flowers some one part is entirely lacking without the others being enlarged or multiplied. This disease is especially prevalent on plants which have been transplanted from one region to another; however there are some which lack certain parts even when growing in their own soil.

It is generally believed that insufficient heat is the cause of the disease, as it is most often observed on plants foreign to cold climates; yet I doubt whether insufficient heat is the only cause. Our common *Glaux,* which each year beautifies our beaches with its small flesh-tinted flowers, grows, according to Adanson's testimony, in Paris, without petals. This cannot be due to lack of heat.

1st Species: *Deformity of the internal perianth.* This form is common with us on various plants from warm climates; sometimes no corolla whatever develops, sometimes it is so small that it does not deserve the name.

2nd Species: *Deformity of the stamens.* It is very unusual to find plants entirely without stamens, except in the case of the double flowers; however we often find fewer than is natural. On those plants which have 10 stamens (Decandria) this form of the disease is very common.

3rd Species: *Deformity of the stem.* We often find plants whose stem is lacking though that or-

gan should by rights be found. However in spite of this flaw they blossom and set fruit. Certain thistles are especially subject to this.

4th Species: *Deformity of the leaves.* The leaves are changed to mere scales which conceal the stem.

CLASS IV

Extraneous

Genus I. Necrosis. *Sphacelus*

Necrosis consists of the sudden stoppage of the growth; the plants immediately wither, become black, dry, and finally die. There is a general form of this disease by which the entire plant suffers, and a form in which some part of the plant is attacked and falls off without the remaining fresh parts suffering in any way, or being checked in growth. The disease is very common on *Ulex Europaea,* a withered branch almost always disfigures this otherwise handsome bush, making it little adapted to hedges.

The cause of the disease is a stoppage of the sap; this in turn is always the result of external injury. As soon as the sap ceases to flow, the plant itself, or the part affected must wither up and die; the blackish, dry color it assumes is the outer sign.

1st Species: *Necrosis due to cold.* In our northern lands it is very common for our plants to

freeze and die from cold; this is especially the case in the spring when the sap has begun to flow. The cold of winter very rarely injures our plants, but the severe frosts of nights in the spring expand and split the vessels already distended by nutritive sap, and the part thus attacked dies. The more beautiful, warm and moist the weather has been, the more harm is done during a frosty night. Plants growing in low, damp places always run more danger of freezing than those growing on high, dry places. On that account it is difficult to determine which plants can endure our winters; it is not always the very low temperature which kills the foreign plants, but as a rule the circumstances attendant on the cold, from which indeed, many of our native plants die.

2nd Species: *Necrosis due to heat.* Adanson (2) cites examples of strong trees which were killed in a single morning by the reflection of the sun's rays on the windows of a conservatory.

3rd Species: *Necrosis due to suffocation.* This form of disease is observed on pine and spruce trees whose lower branches cease to grow as soon as they are overshadowed by the upper.

Genus II. Leprosy. *Lepra. La Mousse*

Adans., I., 45 (2)

Leprosy consists in the covering of the outer bark (of trees) with various species of moss; these

continue to grow there and impede the evaporation of the tree. These mosses apparently do no actual harm to the tree on their own account, nor do they deprive it of sap, as they rest on the outer surface of the bark alone without penetrating into the actual substance of the tree. However, when they appear in any quantity, they are always an indication of a poor condition of the tree. On young trees in rapid growth and on healthy trees, moss is rarely seen, but more often on the old and weak. There are many varieties of these mosses and they seem intended by nature to absorb sour stagnant juices, which form the greater part of their nourishment. They either have no roots at all or else roots too fine to penetrate into the soil or trees but remain solely on the surface. Under every period of heat or drought they dry up, show no sign of growth or life, until a subsequent moist period gives them new nourishment and new life. Everywhere where juices are checked and become acid and pungent to a degree destructive of all other plants, these mosses are found in great abundance, occupying every nook and corner. That is why they soon appear on flower-pots which are heavily watered and which have no drain, that is why we find them on acid meadows where only a few plants can thrive. However, in my opinion, these mosses do not actually injure either the meadows or the trees; on the other hand though,

they always indicate the presence of an unhealthy condition, and the poorer this is, the more gaily grow the mosses. This is beautifully illustrated on trees, for the mosses continue to grow even though the tree is felled or dead. Is it not possible that a rotten or acid evaporation from the tree also contributes to the growth of mosses?

It is customary to clean trees in gardens by using a scraper. The advantage thus gained is dubious unless other measures for stimulating the growth of the tree are taken at the same time.

Genus III. Lousiness. *Phtiriasis*

Lousiness is the accumulation of a countless number of plant-lice which attack plants or parts of plants, suck on them and destroy them. Every species of plant has its own species of plant-lice; these often appear in such quantities and suck so much sap that they contribute in no small degree to the withering of the plant. They are prevalent in especially great numbers on all plants whose growth is unsatisfactory, due either to unsuitable soil or to a disease of whatsoever nature. This is why we often find them on carnations planted in too rich soil, or on hops suffering from honey-dew.

There are many insects which we group under plant-lice, those for instance which Linné, the Knight, designates as *Aphis, Coccos* and *Chermes;* all of these injure our plants in the same way, by

sucking the sap. However, *Aphides,* which are the most numerous, are the most injurious, and it is they which are generally known as plant-lice. They attack all parts of the plants, even the roots below the earth, still they prefer the young shoots or branches from the preceding year, where the bark is fresh and tender. Other forms cause the leaves to assume lumpy, warty excrescences, as seen on currant and other bushes, and still other forms attack the fruit growing on the plant.

1st Species: *Plant-lice on healthy plants.* It is very uncommon to find a plant totally free from plant-lice, but as long as the plant is in good development and there is sap in sufficient quantities, they only do a minimal amount of harm; compensation is soon given in the constant flow of the sap.

2nd Species: *Plant-lice on delicate plants.* As soon as plants suffer, nature does all in her power to dispose of them so that the stage she sets may ever be fresh and perfect. Plant-lice are of the greatest assistance in this, since they take possession of, suck upon and totally destroy weak plants, or those growing in unsuitable soil.

Almost countless are the remedies for plant-lice mentioned in agricultural publications; however these cannot be used, partly because they crave such great expense and trouble and partly because they are of no avail. If our plants are in a suffering and weakened condition, it is almost impos-

sible to get the better of plant-lice which are almost myriad in their fertility. It is then better to prevent the disease by a wise choice of methods of cultivation, than to use remedies against it when it has once gained access.

Genus IV. Langour. *Deliquium*

Langour consists of the cessation of all growth and feeling in plants. The leaves hang limp; they seem withered and dead, but in a few minutes they recover and are as sound and healthy as before. I do not know whether I dare to group *langour* among the diseases of plants as it does no harm and seems rather to be a quality than a disease. Moreover it is seldom observed, we know but few plants attacked by langour, some *Mimosa* species for instance, and *Oxalis sensitiva,* and perhaps a few others.

The cause of the phenomenon seems to lie in the sensitiveness of the internal pithy parts. Adanson (2) claims that it is due to strong contraction, for the parts of the plants cannot be replaced in their former position without breaking them. As yet we know too little about the nervous system of animals and plants to be able to show all the effects it may have.

Genus V. Wounds. *Vulnus*

Wound is the name given to every injury of the external parts, whatever the cause may be. There

are, then, many kinds, and our plants often suffer much under them. I will not include here the various cuts which we administer, partly to their benefit, partly to their improvement,—the pruning of trees for instance and others which form a very necessary part of our horticultural science.

1st Species: *Wounds caused by animals.* Creatures, both wild and domestic can cause considerable damage to our plants, especially in our forests by breaking off and tearing down the plants. Sometimes they gnaw the bark and sometimes crop the tips of the young bushes thus rendering the tree a permanent cripple. It no longer shoots up high into the air but spreads; the side branches grow out and the trunk is forever bent and crooked.

2nd Species: *Wounds due to insects.* Insects do the greatest harm both from the point of view of economy and of beauty. They injure and destroy everything. Some years insects alone are sufficient to destroy all hope for a rich harvest. There is no part of the plant which they do not attack. Some devour the roots, some attack the bark, some destroy the leaves while others injure the blossoms and the fruit. If we had a closer acquaintance with the nature and characteristics of these small pests, we could more easily prevent the harm which they do.

3rd Species: *Wounds due to parasitic plants.* Parasitic plants are those which plunge their roots deep into the substance of another plant and thus drain it of some of its nutritive sap. There are various kinds of parasites and they attack different parts of the plant. Some fasten to the roots, others hang to the branches and trunk; among these *Cuscuta* and *Viscum album* are the most common and the most pernicious here in Europe.

NOTES BY ERNST GRAM

THE system as given in the introductory paragraphs is slightly altered in the text, Fissures being added to Class V which is there called Injury. Furthermore the sequence of Classes II and IV is changed.

Class I, Genus II. Fabricius's opinion of smut, that it is neither caused by any kind of fermentation in unripe seed grain, nor by the soil, but by "something organized," *i.e.*, something living, an organism, forms one of the good reasons why he is ranked among the fathers of Phytopathology. He admits that nothing is definitely known, but in his hypotheses he takes a step farther than Tillet and his main source, Adanson (2). The latter author examined the spores under the microscope, and concludes that smut is caused by a plant similar to "Vesse-de-loup" (Lycoperdon), cold and moisture being the primary, the spores the secondary cause. A contemporary author, Aymen, even assures that he has produced smut with spores from Lycoperdon, and in 1775 Bjerkander calls smut *Lycoperdon tritici*. The indications of worms in smutted grain may possibly be due to

confounding smut balls with the galls caused by *Tylenchus tritici.*

Class II, Genus I, Art. 4. Acaro telario: Red spider (*Tetranychus althaeae*). The grouping under Choking apparently suggests, that not the sucking, but the web of the mites is the cause of the wasting.

Class III, the "Discharging" referred to in the introduction. Genus III, Honey-dew. When Linné (11, pp. 49–50) indicates the larvae of the lepidopter *Phalaena humili* (*Hepialus humuli*) as the cause of honey-dew, it is based on his own observations and experiments. Linné actually reared the imagoes, which deposited plenty of "seed," strewed this about his hop vines, after which he found next year "—that their larvae had attacked the root vigorously. I found moreover a great shoal of lice or *Aphides* on the leaves. Thus I think that the said lepidopters devour the root, making the hop vine sick, after which the lice or *Aphides* appear." The description of Fabricius only covers the honey-dew, the wording of Adanson covers essentially the mildew or perhaps also sooty mould. The term used by both, le Givre, properly means hoar frost. As late as 1796 Rafn (13) describes mildew as "spots first sticky later as a meal." When these spots are sticky the disease has been called honey-dew, and ascribed either to insects, or to dew, etc. "I estimate it in

no wise to differ from mildew, except in its relation to the duration of the disease as the sticky liquid is changed by the heat into a dry or mealy substance."

This confusion of mildew and honey-dew, perhaps due to the frequent coincidence on hops, is but slowly disentangled. For several species of downy mildews Linné applies the name *Mucor erysiphe,* thus undoubtedly classing them among the fungi. Hedwig used Erysiphe as an unpublished genus, which was adopted by Lamarck and Candolle (8), but the mildew of hops was not classified as *Erysiphe macularis* before 1829–32, by Elias Fries.

But from antiquity honey-dew has been considered a perspiration, either of the firmament (Pliny) or of the earth (Galen), and as an exudate of plants it goes bravely on. A few years before the attempt of Fabricius, Lerche (9) personally discovered the true, modest nature of honey-dew, but although his thesis was well known it was buried by many kinds of strange theories. Of these, one proposed by Goethe, that plant-lice subsist on honey-dew and multiply the livelier, the more honey-dew they are offered, may be called the most preposterous. In the 40's, Kaltenbach confirmed the observations of Lerche, but still a generation later such prominent scientists as Hooker and Darwin—and among the Phytopa-

thologists *Sorauer*—considered honey-dew to be a plant secretion. The proper interpretation actually seems to have gained credence from a work of Büsgen (3) 1891. For sake of completeness it may be remarked, that honey-dew has also been applied to the conidial stage of ergot (Claviceps).

Class IV, Genus II, Art. 4. Putrefaction in saffron, *mort du safran,* caused by *Rhizoctonia crocorum* was described, 1728, by Duhamel (5).

Genus III, Canker. Descriptions of Adanson and Fabricius do not cover the usual symptoms of *Nectria galligena* canker.

Genus IV. Rust. Adanson's short paragraph on rust is verbatim: "La Rouille (Rubigo of Teofr.) est une poussière jaune de Rouille ou d'Ocre, répandue sous les feuilles, sur-tout de Rosier and du Titimale à feuilles de Ciprès (*i.e.,* Euphorbia cyparissias). Elle reconoit la meme cause que le Jivre (*i.e.,* mildew and honey-dew), et pouroit etre écartée par les memes moiens." Duhamel (6) seems most inclined to consider rust as a juice, exuded through the rust pustules and then dried (Vol. I, Book III, Chapter II, Art. I).

Class V, Genus II, Galls. The opinions of Fabricius on ergot cannot originate from the book of Adanson cited, since this author mentions its occurrence on rye and other Gramineae, and on "souchet" (Cyperus spp.), as the great venomousness, and speaks of its prevalence in moist

seasons. Ergot poisoning had been frequent in Holstein in the century previous to the appearance of Fabricius's paper, but while ergot had earlier been indicted, in this period many physicians considered it harmless (10). Neither can the information given by Duhamel (6) be Fabricius' source. What the author meant by ergot in Lotus and Cerastium is not known; possibly a gall (*Dasyneura loti* DG) and the anther smut (*Ustilago violacea* Poetsch.), respectively, may have given rise to the statement.

Genus IV, Glaux, Adanson (2), page 112.

Class VI, Genus IV, Mimosa, Adanson (2), pages 56–58.

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